ON

MINERS' NYSTAGMUS.

a Thesis

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by

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I 9 I I.

C O N T E N T S.

M I N E R S' N Y S T A G M U S. I

Definition. An Industrial Disease occurring only in coal miners, characterised by involuntary, rythmical, and usually bilateral oscillations of the eyeball.

Since I86I, when miners' nystagmus first came under the notice of the Medical Profession, the question of its aetiology and pathology has been the subject of much controversial discussion in Ophthalmological circles. A better term in the light of more recent investigation on the subject would be Colliers' Nystagmus, for it is now practically conceded that of all miners it is only the coal miner who is affected, but I have adhered throughout to the

original nomenclature, rendered familiar by usage.

As with most subjects not yet passed beyond the controversial stage, the available literature is based on isolated theory and loaded with more or less destructive criticism, - the whole consisting of a series of monographs on some one particular phase of the subject which has attracted the attention and observation of the individual writer. Each author is concerned only to prove that the one particular causal factor discovered by him is the essential condition in the aetiology of the disease. In fact so completely have the different observers annihilated one anothers' opinions, that the student is left with the impression that the whole subject is still submerged in a sea of doubt and contradiction. Probably much of this diversity of opinion is due to the fact that the subject has not yet been approached

from a sufficiently broad and inclusive point of view. Keeping in mind the variety of abnormal conditions under which the collier does his work it is not difficult to admit that there is probably more than one factor responsible in the causation of the malady. Granted this, we are still faced with the question why, of many colliers working under all these adverse conditions, some do, and some do not, develop the malady. Obviously the explanation is to be sought in the individual affected. This one might call the determining factor - the personal equation, so to speak, in the development of the disease.

In the following sections I shall hope to bring into line as far as possible the existing theories as to causation, and with the help of my own observations as to the above mentioned personal factor, to present a reasonable and consistent solution of

the aetiological problem.

My own observations are based upon frequent examinations of upwards of 100 cases of miners' nystagmus, and some 20 nystagmus cases of other origin; my knowledge of the collier's working conditions has been obtained from special visits to the mines, where I saw the men at their actual work; and much valuable information has been obtained in conversation with some hundreds of miners who have come to the Sunderland & Durham County Eye Infirmary for various reasons apart from nystagmus. These numbers I know are all too few for statistical purposes and the opinions I have based upon them I advance with all diffidence.

I propose to take up the subject under the following seven headings :-

HISTORY.

INCIDENCE AMONGST COLLIERS.

SYMPTOMS AND DIAGNOSIS.

AETIOLOGY AND PATHOLOGY.

PROGNOSIS.

PROPHYLAXIS AND TREATMENT.

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HISTORY.

In I86I Decondé (i) of Liege, in a paper on nystagmus in general published in the Archives of the Belgian Academy of Medicine, reported on two cases of nystagmus in miners.

In I873 Alfred Graefe published three cases.

In I874 Professor Noël of Louvaine reported one case and Mooren of Dusseldorf two.

In I875 Prof. Simeon Snell (ii) of Sheffield, in an article in the Lancet, for the first time attributed the malady to the strained position in which the miners were compelled to work. Snell has stated however that Nystagmus in miners had been observed in this country at least 20 years before these dates by Mr Gillot of Sheffield, but he has unfortunately left no record of his observations.

In I877 Dransart (iii) put on record I2 cases

and at the same time evolved his Myopathic Theory.

In I878 Romiée of Liege (xxxix) published 235 cases and concluded that the malady was restricted entirely to those miners who worked in coal mines, as distinguished from metalliferous mines. This is probably the only observation made in connection with the disease that has not been contradicted by a later observer. Romiée was convinced that nystagmus was due to the insufficient lighting of coal mines and in I9I0 (xxxix) we find him still upholding his original theory.

In I878 Bell Taylor published 5 cases and agreed with Snell and Dransart as to its aetiology and pathology.

In I882 Oglesby (v) read a paper before the Ophthalmological Society of Great Britain . Snell, Nettleship,Mackenzie and others took part in the

ensuing discussion , opinions being divided between the Light Theory and the Position Theory.

In I892, in papers read before the section of Ophthalmology of the British Medical Association , Dr Court of Stavely (xi) and Tatham Thompson strongly supported the defective lighting theory of Romiée.

In the same year Romiée published a report on 900 cases in the Annales d'oculistique. (xii)

In I898 Trombetta advanced a Labyrinthine Theory to explain the occurrence of nystagmus in Miners. (cited by Romiée xxxix)

In I903 Peters adopted and elaborated the theory of Trombetta.

In I906 a Home Office Departmental Committee held an exhaustive enquiry, in London, into the various conditions of work likely to produce Industrial Diseases. The resulting Minutes of Evidence were

published in I907 (Blue Book Cd. 3496). They ~~make~~ make most interesting reading but the views expressed were of a highly contradictory nature. Professor Snell and I2 other Medical men gave evidence, and as a result miners' nystagmus was added to Schedule 3 of the Workmen's Compensation Act. (Statutory Order No. 407, May 22nd, I907.) This enactment may have far reaching effects; employers liable to the expenditure of a considerable annual sum in legal compensation are the more likely to favourably consider prophylactic measures, more or less costly, advocated by the Medical profession.

In I907 the Belgian Government held a Commission of Enquiry into the mining conditions of that Country. The voluminous Medical evidence furnished did nothing to advance our knowledge of the aetiological factors of miners' nystagmus.

In Sept.of last year there was an International Conference on Industrial diseases held in Brussels. Papers on nystagmus read by Drs Romiée and Thibert (xxxix) of Liege, by Dr Moret (xli) of Charleroi, and by Prof. Nuel (xl) of Liege, bring the subject quite up to date . Reference to these papers will be made at greater length in the sections to follow.

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INCIDENCE AMONGST COLLIERS.

It is very difficult to arrive at an accurate estimate of the proportion of colliers affected.

Men, whose livelihood depends upon their physical fitness, are naturally reticent as to defects which may lead to suspension or transfer to less remunerative work ~~work~~ above ground. The tendency is therefore to conceal eye defects as long as they possibly can. far too long in many instances for their safety from accident at work. Many miners rather than come under the notice of their managers will travel long distances to consult a specialist rather than the pit doctor . Hence it is that both managers and pit doctors are inclined to under-estimate the frequency and importance of the disease.

There is a further factor in the difficulty of collecting accurate figures. There ~~MMM~~ is a large

proportion of the men actually affected who have the condition in a mild form without knowing it, ~~and~~ not having experienced any discomfort. Others again have struggled on through moderately severe forms of the malady until, becoming chronic, they have so adapted themselves to the morbid condition that it ceases to cause inconvenience.

Hence the only way to arrive at trustworthy statistics is to make a routine examination of <u>all</u> the men in a sufficiently varied number of pits to give a fair average of conditions in the way of lighting, thickness of seam, methods of " getting ", ventilation, gas etc. Figures obtained on this basis will include <u>all</u> cases, mild and severe, acute and chronic which occur in these mines, whereas those obtained by Medical men who have based their estimates on the number of cases coming voluntarily to consult

them, will only include the cases sufficiently severe to be incapacitated from work. Keeping this in mind the discrepancy in statistics furnished by different observers becomes more apparent than real.

In I892 Court of Stavely, basing his figures upon the examination of all the men in two of the Stavely collieries, states that out of a total of 735 men examined, 207, i.e. 28 % were affected. Taking the actual coal getters, out of 597 examined, he found 34¾ % with nystagmus. Of those engaged in hewing he examined 376 men, and found I72 cases of nystagmus or an average of 45¾ %

In I877 Romiée (xxxix) estimated that 22 % of all miners in Belgium were suffering from the malady and that 35 % of the actual hewers were affected.

At the Brussels Conference in I9I0 Romiée and

Thibert gave the results of the most extensive enquiry that has yet been made into the incidence of the malady.(xxxix) During the years I908 - 09 - I0 they were permitted to examine the men of 27 collieries immediately on their coming out of the pits. In all 5,093 colliers were tested and of these I,075 were found to have nystagmus, i. e. 2I %. They gave separate figures for the coal hewers as follows:- of all the hewers, working in pits lighted with safety lamps of a type burning thick oil, 39 % had the malady, whereas the hewers in the pits lighted with benzine safety lamps, which give a much better illumination, were only affected to the extent of 25 %. Their estimate for all hewers therefore works out at 32 %.

Professor Nuel,(xl) at the same Congress agreed with these observers that at least 20 % of all Belgian miners were the subjects of nystagmus; he

also stated that Dransart in France, and Nieden in in Germany, have estimated that the proportion is quite as high in those countries.

In England Court of Stavely has estimated it to be even higher, but at the Home Office Enquiry in I907 it must be noted that many of the Medical men gave figures that did not exceed 5%. This diversity of opinion may be due to the fact that they practised in districts where the working conditions of the mines are exceptionally good as to thickness of coal seam, lighting etc. or it may be due to their basing an opinion solely upon the number of men who voluntarily came to consult them, in other words their estimates really represent the percentage of severe cases.

As the men become more familiar with the provisions of the compensation act no doubt we shall find that the Government Statistics of Compensation

will afford a fairly accurate index of the number of men throughout the country who have the disease in a severe form. To show the necessity of waiting a while before drawing conclusions I need only point out that in 1908, the first complete year under the order, only 460 men received compensation for nystagmus whereas in 1909 the numbers had increased to 1,011, but we should be quite wrong in assuming that the apparently rapid increase of nystagmus was due to anything but the ~~increased~~ growing confidence of the men in the working of the act.

To sum up:- it seems probable, that of all colliers, at least 20 % have nystagmus; that the actual hewers furnish the highest proportion; that the disease is more frequent in the worse lighted pits, and that the percentage of serious cases is comparatively small.

SYMPTOMS AND DIAGNOSIS.

Subjective Symptoms.

(a) Apparent movement of Objects. This is by far the most constant symptom complained of in miners' nystagmus. The lights in the pit are said to dance about before the patient's eyes, and he sees a circle of lights, or a line of lights, where there should be only one. At first this is only noticed at the end of a shift, and relief can be obtained by a few minutes rest with the eyes looking down. Soon however the dancing commences earlier in the shift, and next it begins as soon as he enters the pit. Then he begins to notice it at dusk, even when he is not in the mine, and eventually it is always present or is brought on by the slightest upward gaze at any bright object.

(b) Vertigo. Giddiness and a general sense of

confusion are a common complaint in the more severe cases.

(c) Pain. An aching pain in the eyeballs, in the supra-orbital region, and in the small muscles at the back of the neck, is frequently complained of. Occipital headache is also a symptom in certain cases.

(d) Photophobia. This symptom, so described by some observers, I have usually found to be not a true intolerance of direct light,but a sense of discomfort and confusion caused by the apparent rapid oscillatory movements of all bright points, especially those set up by artificial lights. I have had no complaint of actual pain on exposing the nystagmic eye to direct light.

(e) Night Blindness. A certain number of cases complain of a difficulty in finding their way about as night comes on. This is probably due to

the fact that night repeats the somewhat confusing lighting conditions of ~~his~~ the miner's work, exacerbating the oscillations and thus increasing his confusion of vision. This symptom invariably disappears as the case improves; therefore it is unlikely to be due to any defect of retina or optic nerve.

(f) Defective Vision. Many of the patients complain of blurred vision or short sight. On careful examination I have always found that when any refractive error, which may be present, is corrected by suitable glasses, the actual visual acuity becomes normal at such times as the oscillatory movements are under control. From this one may conclude that nystagmus does not produce changes which permanently involve visual acuity.

Dr Meighan of Glasgow in his evidence before the Departmental Committee of I906 (xvi) does however

mention two cases of optic atrophy which he attributed entirely to nystagmus, though his description of the cases suggests that tobacco and alcoholic excess may have played their part.

Here I might conveniently make the statement, that in my experience practically every case of nystagmus that presents himself for treatment has an error of refraction, which is nearly always astigmatism. This is a condition which is easily overlooked in an eye where the oscillatory movement renders retinoscopy difficult.

Objective Symptoms.

(a) Oscillations of the Eyeballs. The condition pathognomonic is essentially a rythmic, involuntary oscillation of the eyeballs. It is practically always bilateral and the movements conjugate. However certain one may be, from the

subjective symptoms, that the patient suffers from nystagmus when in the pit, a diagnosis should never be made until the oscillations have actually been observed. The rate of oscillation varies from 2 to 8 per second,—it becomes more rapid when the patient is excited or when he is conscious of being watched. They can usually be brought out or made worse by directing the gaze to a point above the horizontal and they can be stopped by looking down to the ground.

(b) Ptosis. This has been described by some observers as a symptom of nystagmus. It is as a rule the outcome of the characteristic attitude of the head referred to later on.

(c) Head movements. Rythmic movements of the head from side to side are often seen in bad cases, they are supposed by some to be an attempt on

part of nature to produce a stationary image on the retina; by others, to be but an expression of ~~the~~ a general nervous instability.

(d) Characteristic attitude. The miner with severe nystagmus carries himself in a peculiarly upright position with head thrown back , drooping eye-lids, and depressed orbs. This is for him the position of most complete ocular rest. He is now able to look straight in front of him, though his eyes are really in a position of depression - the exact converse of the elevated gaze inseparable from his working position, which will be discussed later on.

(f) Twitching of the orbicularis, and other muscles both of face and neck, are seen in some cases of the disease.

Diagnosis.

The diagnosis of a severe case of nystagmus may be made as the patient walks into the consulting room. He seems to be dazed and his movements are uncertain, he carries his head well thrown back and, it may be, oscillating from side to side. His eyelids droop and quiver, and he blinks frequently in an attempt to steady the oscillations of his eye-balls. To confirm the diagnosis it is only necessary to look at the patients eyes when he is gazing at an object slightly above the horizontal plane and they will be seen to be oscillating more or less violently.

On the other hand when dealing with an incipient case it may be difficult or even impossible to set going the oscillatory movements of the eyes, although, from the subjective symptoms described, one feels morally certain that the patient suffers

from nystagmus when in the pit; for it is recognised that a miner may show oscillations at the end of a days work which quite disappear after a nights rest.

In these early cases the movements can often be produced by making the patient assume, in the dark-room, a cramped position similar to the one he is compelled to adopt at his work. In most mines the men are never able to stand in an upright position owing to lack of vertical space. To avoid knocking their heads against the roof they have to walk and work with bent backs and with heads flexed upon chests and this means that to look in front of him a man must really bring his eyes into a position of elevation - a condition of affairs which I shall show later on to be in part responsible for the onset of nystagmus. With our man in the dark-room then, we make him bend forwards and while pressing ~~our~~ a hand upon the top of

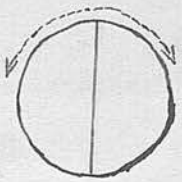
his head ~~and~~ we ask him to gaze at a lamp held above the level of his eyes.

If this method fails it is a good plan to throw a strong light on to the fundus oculi by the direct method of ophthalmoscopy. This usually brings on the Nystagmus, and by focussing a vessel on the optic disc one is enabled to detect in a magnified form the most minute oscillations.

I find the Javal-Schiotz Ophthalmometer can be used to study the character of the oscillations seen in nystagmus. Having seated the patient before this instrument I arrange it so that the reflections of the mires are all intersected by the vertical meridian of the cornea. Then by carefully watching through the telescope the excursions of this line of light it becomes possible to analyse into their component parts the various forms of oscillation.

When examined, thus magnified, the irregular movements are seen to take place in all directions,but usually, in a given case,one type predominates over the rest and serves to describe the nystagmus. The varieties met with are usually termed Rotatory, Lateral,Vertical or Oblique,as the case may be,but intermediate stages are often seen and one variety may pass into another as the condition progresses.

Rotatory nystagmus is seen in two distinct forms - (I) A rotation around the antero-posterior axis of the eyeball in which the centre of the cornea appears to be fixed while its peripherary describes a movement something like that of the balance wheel of a watch.



(2) A movement of the eyeball around its centre of rotation in which the centre of the cornea appears

to describe an irregular circle or ellipse.

Lateral Nystagmus is an oscillation of the eyeball from side to side about a vertical axis.

Vertical Nystagmus is an up and down movement about a more or less horizontal axis.

Oblique Nystagmus is comparatively rare and is always accompanied to some extent by axial rotatory movements of the cornea.

A very few cases of miners' nystagmus have been described in which the oscillations were of a different type in the two eyes and also cases in which one eye only was affected but they are very rare. On the other hand I have notes of a case in which nystagmus developed some years after the right eye had been enucleated. The left eye presented well marked oscillations and on looking at the stump of the right eye it was seen to be

exhibiting similar movements. When this patient wore a glass eye the nystagmic movements, though less marked, were transmitted to it in a wonderfully life-like manner.

A convenient way of recording the degree of nystagmus in various cases has been suggested by Romiée and Thibert (xxxix) They point out that the intensity of the malady is in inverse ratio to the height of gaze necessary to start the oscillations, and they show that a reliable standard of comparison can be obtained by "taking the angle, that the horizontal plane passing through the centre of the eye makes with the visual axis, when the gaze is directed to the least elevated position necessary to produce oscillations."

In the records of my cases the angle has been estimated by a modification of the Maddox

Tangent Scale, and I have found the method of great value in observing the progress of a case from week to week.

In briefly summing up the subject of symptoms and diagnosis it is convenient to divide miners' nystagmus into three stages, Incipient, Acute, and Chronic.

In the Incipient stage the patient may complain of some of the subjective symptoms, such as dancing of lights, giddiness, confusion of sight etc and yet it is with the greatest difficulty that the oscillatory movements can be brought out. This stage may persist for a long while without further development and then a sudden fright, an accident, or even a period of ill health may quickly convert it into an acute form.

In the Acute Stage both subjective and objective symptoms are well marked and persist even

even when the patient is out of the pit. There is great discomfort and in many cases it is impossible for the collier to continue working. Some of the less severe cases do persist in their work and, after considerable suffering, eventually reach the chronic stage.

In the Chronic Stage the oscillations are usually well marked, but the patient having grown used to them suffers very little inconvenience. His condition is now very similar in this respect to that of an albino who has no sensations of ocular movement because by long practice his visual centres have learnt to interpret the moving images as if they were stationary.

AETIOLOGY AND PATHOLOGY.

The aetiology and pathology of miners' nystagmus are so intimately associated that it is convenient to discuss them together. In doing so I shall first consider the causes of nystagmus in general, hoping thereby to elicit some conclusions which may throw light on the subject of miners' nystagmus. Next, the conditions under which the collier has to work will be studied, then the theories already advanced by different observers as to causation, and finally I propose to add some facts of my own observation and a theory that will at anyrate place the subject upon a broader basis than has yet been attempted.

(I) The Causes of Nystagmus in General.

(a) Conditions giving rise to very defective

vision in both eyes in early infancy, such as congenital cataract, opacities of the cornea especially those following purulent ophthalmia, aniridia with associated defects, high astigmatism, haemorrhages , central chorioiditis, complete congenital colour blindness, and invariably albinism - all have been credited with the production of nystagmus. It is significant to note that these subjects of congenital nystagmus are unconscious of the ocular oscillations and never complain of the apparent movement of objects so troublesome to the miner. Also that when the above defective conditions are unilateral they give rise to strabismus - very rarely indeed to nystagmus.

(b) Nystagmus is found in certain diseases of the Central Nervous System, ~~of which~~ e.g. Disseminated Sclerosis, Friedreich's Ataxia, Cerebellar Tumours,

Cerebral Tumours and Lateral Sinus Thromboses.

(c) Certain cases of Infective Labrynthitis exhibit nystagmoid movements. Ewald has shewn us that there is an intimate connection between the semicircular canals and the co-ordinating mechanism governing the ocular muscles.

(d) Nystagmus has been known to occur in patients anaesthetised by aether. Alcohol, Sulphonal, Benzine and the toxines of Influenza have all been said to produce nystagmus.

(e) Nystagmus has been produced in workers at other occupations than coal-mining, presumably as a result of the strained position associated with the work. Type-setters, platelayers, saw- makers etc have all furnished instances of occupational nystagmus.

(2) Conditions of Work in a Coal Mine.

All underground employees in a coal mine work

under conditions which impose great strain upon the ocular functions, both visual and motor. The muscular strain arises from the cramped position the men have to adopt, while the visual strain is caused by the bad lighting of the pits.

(a) Position. The Geological formation of the coal-seam determines the amount of vertical space which the men, at a given pit, would have to work in. Seams vary in thickness from two to six feet - the average in the Durham coal fields being about 3 ft 9 in. Above the coal there is shale or solid stone, known as the roof, below is more shale or stone - the floor. The business of mining consists in getting out all the coal between floor and roof. As work proceeds every yard of the roof is propped up with wood. This further encroaches on the available working space. None of the miners in the majority

of pits are able to stand in an upright position,from the time they enter the pit mouth till they again reach the surface. Whether a man be walking to his work - and some of them have to walk two or three miles underground before they reach it - or filling the tubs,or timbering the roof,or actually hewing the coal,he has to do it in a stooping position with his head either flexed forward on to his chest,or laterally towards one shoulder,- even the pit boys who drive the ponies are not as a rule able to walk upright.

This stooping posture so alters the direction of the orbital axis that a man wishing to look in front of him has to bring hie eyes into a position of elevation and, though it seems paradoxical, it can be readily demonstrated that the less vertical space the miner has to work in the greater will be the

strain thrown upon the elevating muscles of the eyeball. Snell cites an interesting case of Nystagmus in a plate-layer which illustrates the effect produced by this position of strain. In his work this man had to bring his head to a low level, and to look along the rails to see that they were laid truly in line.

The position of relative ocular elevation is most trying to sustain for any length of time, and the point I wish to emphasise is that no one in a coal mine is exempt from it, and that it has to be maintained during most of the working day.

(b) Lighting. So much for the muscular strain - the visual one is even greater. To those of us who only pay an occasional visit to a mine the miner seems to do his work in darkness. In those mines where it is safe to use a naked light the

miners candle gives at best but three quarters of the light of a standard candle, and this is further reduced in value, by reason of the absolutely black surroundings, which absorb instead of reflecting the light. Compared with the old Davy lamp however the naked lights are brilliant. In the majority of English mines a safety lamp of the Clanney or Marsaut type has to be used. These lamps are a modification of the old Davy pattern - the wire gauze around the flame being replaced by a thick piece of glass, and in the case of the Marsaut, the gauze above the glass is protected from dust and draught by a metal bonnet. Such a lamp at the beginning of the day gives from two thirds of, to about the same light as, a standard candle, but at the end of 3 or 4 hours the flame begins to fail, the lamp gets dirty and the light is reduced to about one half that of a standard candle

Each man has but one lamp which he carries about with him but to avoid the risk of breakage he is obliged by law to hang it up at a safe distance from his work. Taking into consideration all these light-reducing factors one gets some idea of the Stygian blackness that prevails, and of the constant strain upon the whole apparatus, from retina to visual centre, that is involved in the effort to translate into definite images the blurred impressions that are thrown upon the retina.

All grades of workers suffer under the conditions of position and lighting described above, but the actual hewers of coal are the most affected. Their work requires more precision in manipulation. They have often to hew in a sitting position or even lying upon one side with head and eyes directed obliquely upward. Their lamps must

of necessity be hung more or less behind them and as a result the pick is constantly passing from light into shadow and vice versa. ~~In some places~~

In some places the coal is "got" by a process known as"holing" It is not done to any great extent in the Durham districts but is very common in the midlands and probably causes greater eye strain than any other form of hewing. In ordinary hewing the men undercut the face of the coal as near to the floor as possible for a distance of from Ift to 3 feet,and then dislodge the piece so undermined by means of the pick or by driving in wedges near the roof or by drilling holes and blasting down with some explosive. In "holing" the miner lies upon his side with head and eyes turned obliquely upwards and works his way under the coal face for a distance of from 4 to 8 feet, propping up

the coal as he goes. , The undermined piece of coal, often a matter of several tons, is then dislodged - either by simply withdrawing the props or by wedging, or blasting.

The other abnormal conditions under which a miner may have to work include :-

(c) Increased atmospheric pressure and heat, both depending upon the depth of the mine below the surface, which may be anything between 100 feet and 1800 feet - the average being about 900 feet.

(d) The presence of Dust. In dry pits, more especially if the coal is soft, dust may be abnormally plentiful. It diminishes the light both by absorption and by clogging the lamps, and it has an irritating effect upon the sensory nerve supply to the eye, especially in warm pits where the perspiration is apt to carry the particles into the conjunctival sac.

(e) The presence of "Gas, i.e. Carburetted Hydrogen. Apart from its dangerous explosive property this gas is said to have a toxic action upon the Central Nervous System.

(f) Bad air. This is a complaint of which one hears less and less. The modern system of ventilation is so well planned, and the exhausting fans are so powerful, that in most working parts of the pit there is at anyrate free circulation of air, but it is of course impossible to free the atmosphere of the pit of dust, gas , and the products of combustion of the various explosives.

Whether the last mentioned four conditions have much local action or not, they at anyrate, all do something to lower the general vitality of the men.

(3) Theories as to aetiology.

(a) The Theory of Position at Work.

This theory dates back to the year I875 and was then first advanced by the late Mr Simeon Snell of Sheffield. (ii) Shortly afterwards Dransart (iii) in France, and Nieden in Germany, working independently, arrived at the same conclusion.

Snell's book (xiii) published in I892, still remains the most exhaustive treatise on the subject in the English Language, and as it contains extensive quotations from the work of Dransart and Nieden, I shall make it the basis of my remarks on the position theory.

Snell in his earlier writings was of the opinion that the malady was restricted to those hewers who were obliged to work lying upon one or other of their sides - thus limiting it , in his district at

anyrate , to the men actually engaged in"Holing". Later he agreed,that other men whose work necessitated a position of head and eyes similar to that assumed in holing,might develop the malady.

He bases his conclusions upon the following figures and facts. Firstly, that out of I27 cases of miners' nystagmus he found:-

II9 were coal getters.
3 fillers.
2 deputies.
2 onsetters.
I engine-man.

Secondly,he has found the malady in other occupations than mining,when the work necessitated a severe atrain on the elevating muscles of the eyeballs, notably in compositors, metal rollers, a plate-layer, a plank sawyer, and a stableman whose chief duty it was to hang up harness. Thirdly, on a visit to a

metalliferous mine in Cornwall he carefully examined the working conditions and stated that " there was not much difference in the light of the place, except that the walls had a less black look than in a coal mine..... ....."The stope " was of such a height that a man could work standing perfectly upright; in some mines the places are very lofty and large.....There was only comparatively a trifling amount of pick work done or indeed required , as explosives were extensively used". And after extensive enquiries he was satisfied that nystagmus was unknown in the Cornish metalliferous mines.

Snell in further support of his Position Theory discredits the fundamental importance of the lighting factor in the following terms:- " It is impossible to regard the employment of safety lamps in the mine as an essential element in the causation

of nystagmus. Abundant evidence has been adduced of men being afflicted who had never so much as used a safety lamp. Nor can the imperfect illumination of coal mines be accepted as an essential element in causation. For not only has nystagmus, according to the advocates of the safety lamp theory, not diminished with the improvements which have been shewn to have taken place in the lighting of the pit, but the presence of the malady has been demonstrated in men working with naked candles, torches, and in such good illumination as that at the shaft bottom. ..... morover it has been shewn that whilst all in the mine work with the same light all are not equally subject to nystagmus. "

Snell therefore came to the conclusion that the "prime and essential cause" of the nystagmus was the position of the miner at his work, and he summed

up in the following words:- " It is occasioned by the fatigue of the superior rectus, inferior oblique and internal and external recti muscles, induced as a consequence of the miners' work in the pit necessitating an upward and more or less oblique gaze. It occurs irrespective of the mode of illumination."

If one might criticise Snell's findings,it could be pointed out that one of his arguments against the light theory might be transposed to equally discredit the position theory. viz. , That whilst there are many men underground engaged in hewing and even in holing all of them do not develop nystagmus.

Also I think there may be a fallacy,in arguing from the large proportion of hewers affected, that the peculiar nature of their work is solely responsible for the development of the malady. It must be remembered that the hewers have been longer

underground than any other class of men except the deputies. It may be that time is the factor which makes the hewers shew so large a proportion of nystagmic cases.

Snell and Dransart advance the following theories as to Pathology. They say the affection is a myopathic one induced as a result of prolonged strain in an unusual position. They both liken the malady to writers' cramp and other professional neuroses and consider it another instance of muscular disability due to overwork. It is interesting to note that one of Snell's cases of nystagmus in a compositor afterwards developed compositors cramp in his right hand.

(b) The Theory of Insufficient Illumination.

This theory dates back to 1878 when it was first advanced by Romiée. Since then he has probably

examined more cases of nystagmus than anyone else and he is still firmly convinced that insufficient lighting is the main causal factor. His paper written in conjunction with Thibert of Liege (xxxix) and read before the Brussels Conference of I9I0 is the most comprehensive survey of the subject up to date, and it is to this publication that I shall chiefly refer when discussing the views of those who favour the lighting theory.

Before however any further reference is made to their views I would mention the work of Tatham Thompson and that of Court of Stavely, both of whom have strongly championed the lighting theory in this country.

Tatham Thompson (x) in a paper read before the Ophthalmological Society in I89I, gave some interesting facts in connection with work in the

South Wales Collieries. He states that there are two classes of coal in this district - House Coal and Steam Coal. The House Coal is worked in seams which are rarely more than 2 ft 6 in thick,—it is not fiery and there is very little dust, so that the men can use naked lights and get the full benefit of their illumination. But in these seams the men have to work in a very cramped position, usually lying on one side with very little head room. If un-natural position is the cause of nystagmus, he says, we should expect the men in these seams to develop it, yet nystagmus is comparatively unknown in the House Coal pits. On the other hand the Steam Coal seams are thick and the men can work in varied positions, as a rule standing up with plenty of head room, but the coal is "fiery" and dusty so that the men have to use safety-lamps whose feeble light is further reduced

by the dust laden atmosphere. In these pits, Tatham Thompson states, nystagmus is only too frequently met with. He further mentions that House Coal has been obtained since the I2th century, whereas Steam Coal has only been worked for a matter of 60 years, and that nystagmus was unknown until Steam Coal mines with their poor illumination began to be worked.

Dr Court of Stavely, in a paper read before the British Medical Association in I892 and published in book form in that year (xi), denies that the miner's head and eyes are turned obliquely upwards during the course of his work. Court states that the true cause of the disease is the insufficient light given by the safety-lamp which makes the miner strain both eyes and nerves in order to peer into the darkness. "Increase the illumination", he says, "by using the candle, which after all is a poor light, and the disease

becomes rare. Use more light still in the shape of the torch lamp, which gives $2\frac{1}{4}$ times the light of the standard candle, and there is no trouble at all."

Dr Court gives the following figures to support his argument :- Out of I,097 miners examined for nystagmus 524used safety lamps and of these I64 had the malady; 573 used naked lights and only 32 of these were found to have nystagmus.

To return to the work of Romiée and Thibert:- In their paper read at the Brussels Conference in I9I0 (xxxix) these observers advance the following arguments.

Nystagmus is totally unknown in metalliferous mines. It is common in coal mines. The position at work in metalliferous mines, they assert, is the same as in coal mines but the lighting of the former is much superior, (contrast Snell's observations.)

The lighting of mines, they say, has been markedly improved since I87I, while the other conditions of work have remained the same, yet nystagmus has decreased considerably in the same period.

Comparing the percentage of men affected in certain mines lighted with safety-lamps, with that of other mines lighted by electric lamps, they found it to be as 38% to I9%.

In certain mines where benzine lamps , giving a comparatively good light were adopted in place of thick-oil lamps, they found that the number of nystagmus cases was greatly reduced in a period of three years.

To further emphasise their point they selected, as an experiment, I4 men suffering from nystagmus and put them at their ordinary work in the pit, but gave them <u>two</u> benzine lamps each. In a

month's time every case shewed marked inprovement. This improvement they recorded on their own principle of measuring the degree of elevation of gaze necessary to bring out the nystagmic movements, and the results certainly appear to be very significant.

Their conclusions are as follows :-

" Colliers' nystagmus is an occupational malady due to insufficient lighting of the underground work."

"It is of a mild nature; very rarely is it detrimental to work."

With recent improvements brought about in the illumination of the mines it has diminished in frequency and in seriousness."

" It will end by disappearing with the new progress that will be made with regard to lighting."

Romiée thinks that the Pathology of the

affection lies in a deficiency of accomodative power produced as a result of the strain of peering into darkness, without ever being able to bring a definite image to a focus on the retina.

(c) The Toxic Theory.

In I86I Decondé (i) suggested that alcoholic excess was in part the cause of nystagmus in the two cases described by him - both miners. This was the first reference to the aetiology of the malady.

In I893 Pechdo attributed the cause to the poisonous effect of the "Gas" so often present in Coal mines. It is interesting to note that cases of nystagmus have been recorded after poisoning by aether, alcohol, cocain, sulphonal, eserine, sewer gas etc. It has also been produced by the toxins of Influenza. Against this theory however it may be stated that apart from a certain amount of anaemia

miners present no symptoms suggesting a chronic toxaemia. It is a fact also that nystagmus is found in mines that are free from gas. If however it is more frequent in "fiery " mines it must be remembered that where gas is plentiful illumination is bad.

(d) The Neurosis Theory.

Rutten is of opinion that miners' nystagmus is but one expression of a general neurotic diathesis. He even goes so far as to say that nystagmic miners present a uniformity of symptoms of general decay and mental defect to the point of rendering them sometimes irresponsible.

I do not think that many observers will agree that the subjects of miners' nystagmus are generally neurotic. One does occasionally meet with a case presenting nervous symptoms,but as Weekers points out, this is only a complication, not a causal factor.

(e) The Labyrinthine Theory.

Trombetta, about I900, advanced the theory that nystagmus was due to an irritable condition of the Labyrinth induced by the changes of barometric pressure inseparable from work carried on at so great a depth. Peters has also adopted the same view and Benoit and Stassen have recently stated that they have found the labyrinthine nystagmoid reflex, as described by Bárány, abnormally easily excited in miners.

Personally I found, when going down a pit, that I experienced a most uncomfortable sensation of pressure on the ear drums, especially as the cage neared the bottom. For the time being I was absolutely deaf but the simple act of deglutiition restored the normal balance of pressure.

Against the Labyrinthine Theory it must be

stated that Bárány has shewn, (xvii) in his classical work on the labyrinthine reflexes, that the oscillations of vestibular nystagmus have a characteristic rythm easily distinguished from that of miners nystagmus. Bárány also found that to produce nystagmus by increasing the pressure it was necessary that there should be a perforation of the labrynthine wall.

In the absence of further evidence we can but keep in mind that increased labrynthine susceptibility may constitute one of the predisposing causes in the development of miners' nystagmus.

(f) The Theory of Absence of Colour.

Elworthy (xxxviii) in an interesting article in the British Med. Journal has advanced the view that miners' nystagmus is caused by the absence of colour in the pits. He bases his opinion upon the statement that stablemen are the only employees in

the mine who never develop the disease and that the stables are always white- washed. Elworthy goes so far as to suggest that as a prophylactic measure the pits should be coloured daily with some inexpensive wash - " white-wash, or preferably green or other varied colours."

(g) Refractive Errors in Nystagmus.

I had not been three months engaged in Ophthalmic work before I was struck by the fact that practically every case of miners' nystagmus I examined was astigmatic. This led me to pay special attention to the question of refractive errors in these cases, with a view to arriving at some conclusion as to its bearing upon the aetiology of the affection.

During the last two years I have examined upwards of I00cases of miners' nystagmus and I found that 90% of them were astigmatic. I have not found

it an easy matter to estimate the refractive condition of the nystagmic eye, but with patience and by allowing the man to close his eyes frequently and have a rest it is nearly always possible to find a moment in which the oscillations are sufficiently reduced to allow of the necessary observations.

I invariably do a retinoscopy; I confirm the axis and amount of astigmatism by using the Javal-Schiotz Ophthalmometer; and finally verify these findings by the subjective method with lenses and test types.

I propose to include in an appendix at the end of this thesis notes on a series of 20 nystagmus cases. They comprise all the cases that have presented themselves for treatment since Jan. Ist I9II and have not been selected in any way. Every one is astigmatic.

Of the 20 cases :-

7 have mixed astigmatism in one or both eyes.

7 have myopic astigmatism.

6 have hypermetropic astigmatism.

For a long time I failed to find in the literature of the subject any reference to the importance of refractive errors as a factor in the aetiology of miners' nystagmus. But I have recently come across a statement (x) made by Tatham Thompson in I89I in which he affirms that it is rare to find Miners' Nystagmus in an emmetropic eye.

If I might base any conclusions upon my own examinations, limited to about I00 cases,it would be to suggest that astigmatism is probably a most important determining factor in the production of miners' nystagmus. Just how it plays its part we will try to determine in the next section.

Conclusions regarding Aetiology.

Nystagmus in general may be considered to be a perversion of the function of fixation in which the impulses sent out to the various muscles produce a series of unbalanced contractions instead of the normal co-ordinated movements necessary to maintain ocular stability.

We may assume that the disorder has a central origin and is not a local myopathy from the fact that the oscillations are bilateral, rythmical and conjugate.

One only has to consider the various actions of the individual ocular muscles to realise what an exceedingly complicated process the act of central fixation really is; and it is not unreasonable to assume that there may be a special supra-nuclear centre set apart to co-ordinate the delicately differentiated impulses sent to the ocular muscles

in order to produce fixation.

Fuchs has pointed out that "fixation is not a faculty in-born in man but has to be learnt by practice. Very small children do not perform fixation but move their eyes about aimlessly. Now if the retina does not receive well-defined images, the child does not learn to place the eye accurately in the direction required and keep it still." This explains why a child with congenital amblyopia usually has nystagmus. These children go through life with an incompletely developed fixation centre and the resulting nystagmus is an intermediate stage between the wandering ocular movements of the totally blind and the steady fixation of an eye with good vision.

If only one eye is congenitally amblyopic, the child may squint but the eye never becomes nystagmic, because the good eye sends up visual

impressions which train the fixation centre. This in itself is a forcible argument for the central origin of nystagmus.

In the case of toxic nystagmus, one may suppose that the poison acts upon the higly organised cells of this centre.

The nystagmus seen in certain cases of nervous disease is probably due to the involvement of the fixation centre or its association paths to the ocular nuclei. In disseminated sclerosis, with nystagmus, lesions have been found in the Corpora Quadrigemina, Corpus Striatum, Restiform Bodies, Cerebellum and Medulla.

We now come to consider the various ways in which the fixation centre of a miner may become deranged in its functions. Firstly, there may be interference with the afferent visual stimuli which are necessary for its guidance; secondly, there may

be overwork of the centre caused by the prolonged maintenance of unnatural positions of the eyes ; thirdly, there may be central poisoning, and finally, there may be abnormal reflex stimulation.

To take the least constant and presumably, therefore, the least important ones first - it is possible that the poisonous gas, the increased atmospheric pressure - acting reflexly through the vestibular nerve - and the irritating effect of the dust - acting reflexly through the 5th nerve -, may all play their part in disturbing the equilibrium of the fixation centre.

Further, when we come to the position in which the miner has to maintain his eyes for considerable periods at a time, we again see that the fixation centre is unduly taxed. To maintain tired muscles in an abnormal position is a heavy demand on a centre

whose functions are already sufficiently complicated.

Coming now to the question of illumination - the blackness of the mines, the feeble light given by the safety lamp or miners' candle, the dusty atmosphere, all tend to produce a blurred visual impression which provides an imperfect stimulus to accurate fixation. But besides depriving it of its normal visual stimulus there is another way in which the darkness of the mine may derange the function of the fixation centre. It is generally recognised that the fovea centralis is not so sensitive to a minimal stimulus of white light as the rest of the macula lutea, and in consequence the eye when staring into comparative darkness is instinctively moved sufficiently to bring the image on to a part of the macula other than the fovea. Now this movement, infinitesimal though it may be, is in itself a

departure from central fixation, which is very trying to maintain by a centre educated to keep the image fixed upon the fovea centralis.

But after considering all the above theories and statements we are still faced with the fact that, while the majority of miners are exposed to many or all of the influences categoried, only a proportion of them develop nystagmus. This suggests that there is a further factor inherent in the men attacked, which determines the onset of the disease. It is easy to say that the man has a neurotic diathesis, or is in some other way predisposed to the malady, but I am convinced that in most instances the determining factor is an error of refraction. It is significant to note that a few cases of nystagmus in children have been recorded in which the only cause

was almost certainly a high degree of astigmatism.

Undoubtedly all the other factors when combined, may be sufficient in themselves to produce miners' nystagmus in isolated cases, but I am satisfied that the presence of a refractive error greatly increases the risk of developing the malady. In other words the refractive error adds the last straw to the burden which the fixation centre has to carry.

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PROGNOSIS.

Even in those cases whose symptoms are severe enough to make them consult a doctor, the prognosis as to life and vision is uniformly good. Remove the cause, or rather remove the miner from the cause, and it is only a question of time before the symptoms disappear.

On the other hand, the outlook as to a man's capacity to continue the work of a miner, is not so satisfactory; and if he has once had nystagmus badly enough to necessitate his giving up his work for a time, he is almost certain to have a relapse sooner or later when he returns to his old conditions. So frequently in a small proportion of cases do these relapses occur that the men have to give up underground work altogether.

By far the greatest number of miners with

nystagmus, however,continue working for the rest of their lives without suffering much inconvenience, , and in some instances without ever knowing that they have the malady.

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PROPHYLAXIS AND TREATMENT.

The prophylaxis of miners' nystagmus must be approached from at least three points of view:- the lighting of the mines, position at work and attention to refractive errors in the workers.

The question of illumination is probably the least difficult to cope with. The first principle in a lamp,for general use in a mine with gas,must be its safety. Secondly it should give a light of at least 5 c.p. and thirdly it must be easily attended to, and kept clean. The newest type of Benzine

safety-lamp gives but one candle power, and this is not enough.

The solution seems to me to lie in Electric Lighting.

I have recently been making some experiments in this connection, and I find that a portable lamp, worked by an accumulator of four volts, can be easily designed to give 5 c. p.; the whole thing being self-contained, easily kept clean, and not weighing more than 3½ lbs. A metal filament lamp, of such candle power, would require rather more than I ampere, so that the accumulator would have to be charged daily; but most collieries have power stations and this would entail no more time or work than is now spent in cleaning and filling the safety lamps.

With such illumination one of the main factors in the aetiology of miners' nystagmus would be removed.

As to the working position - to enlarge the vertical space is a counsel of perfection, but I am afraid, not practical politics. The expense of removing the stone roof or floor would be too prohibitive. Something might be done in the way of using coal-cutting machines or by the more frequent use of explosives to reduce the actual hewing, but we cannot hope for much amelioration of conditions in this direction.

With regard to refractive errors, we are again faced with a difficulty. Owing to the dust in the mines, and the profuse perspiration of the men, as well as the risk of breakage, it is almost impossible for them to wear glasses. The alternative is to have the men periodically inspected as to the state of their refraction and to transfer to work above ground, all who do not conform to a certain visual standard.

This involves some hardship, I know, but is justified for other reasons besides the prevention of nystagmus. I have often noticed that it is the men with the higher errors of refraction who most frequently meet with accidents at their work - a small fragment of flying coal or steel from a misdirected blow with pick or hammer and a useful eye is lost for ever; and incidentally, the employer is mulcted in compensation to the extent of £200 or more.

Briefly then, the ideal would be well lighted pits, plenty of head room in which to work, and men with emmetropic eyes. Provide even one of these and nystagmus would be much less frequent; with two it would be comparatively rare; provide them all and nystagmus would cease to be.

TREATMENT.

Treatment is summed up in three words - remove the cause. It is only necessary to stop the man's work, and send him out into the green fields and fresh air, to cure him. The time varies directly with the severity of the symptoms, it may be two months, it may be two years. I find the cure is hastened by prescribing suitable glasses to correct the error of refraction - slightly smoked by preference if the patient has complained of intolerance of light. In a bad case it is well to advise the man to go to bed before it is dark enough to require artificial light.

If there is anaemia or other evidence of ill-health appropriate medicinal remedies can be prescribed.

Later on light work may be permitted but on

no account any occupation which necessitates a stooping posture

And lastly it is not safe to send a man back to the pit until fully one month has elapsed after all subjective and objective symptoms have quite disappeared.

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SUMMARY OF CONCLUSIONS.

A summary of conclusions on my main points has already been made in some detail under the heading "Conclusions regarding Aetiology" , pages 6I - 67, but I might re-state in brief :-

(i) Miners' Nystagmus occurs in at least 20% of Colliers.

(ii) It rarely occurs without refractive error and that error almost invariably astigmatism.

(iii) The malady may be regarded as a perversion of the function of central fixation, brought about by the unusual conditions of work and determined by the refractive error.

(iv) The prophylaxis lies in,—improved lighting, increased working space where possible, attention to the miners' refraction.

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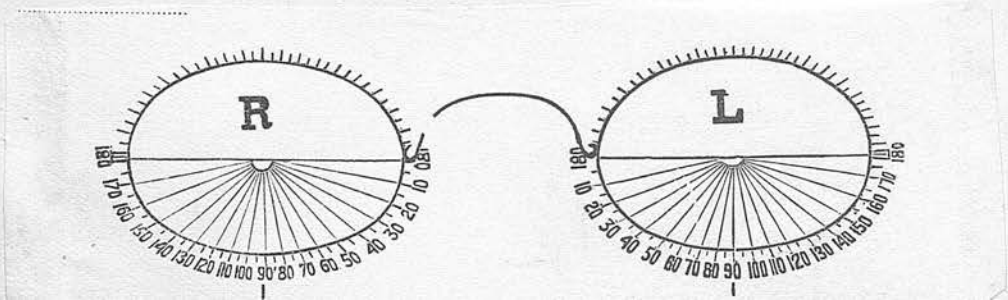
APPENDIX.

The following short notes of 20 cases of miners' nystagmus, taken since the commencement of 1911, have been made as the result of my own examinations and for the purpose of this Thesis. I have refrained from including extracts from the notes of 83 cases which I had previously been able to examine, because the observations in every case were not made, and the notes written, by myself alone. I was however responsible for the estimation of all the refractions and upon these observations I have ventured to base some conclusions.

The attached diagram indicates the system of notation used to record the axes of cylindrical lenses in the following cases.



H.R. aet. 4I

Has been a miner 26 years

Hewing I6 years.

Complaint. Lights in the pit going round and round. Coal face dancing up and down. Pain in eye-balls shooting to back of head. Giddiness. Sees badly in the dark.

Duration. 9 months, since first symptoms.

Work Seam is 2ft 4 in. thick. Patient works mostly in a lying position, he undercuts the coal to a distance of 3feet and then blasts down the piece.

Lamps. Clanney type. i.e. a safety lamp burning thick oil, protected by gauze above the flame and glass around it. Light as a rule equivalent to about two thirds of that of a standard candle.

Nystagmus Rotatory type, centre of cornea describes an ellipse. Brought out when I5° above the horizontal.

Refraction. R.E. + I. D. spher ⊃ + I.25 D. cyl. 75°

R.V. = 6/6

L.E. - I.D.sph.⊃ + 3.5 D. cyl. axis 90°

L.V. =8/I0

S.E. aet 35

Has been a miner I2 years.

Has been coal hewing I0 years.

Complaint. Lights going round in circles in pit, also street lamps at night. Saw a circle of lights where there was but one. Pain at back of eyes.

Duration. 2 years since first symptoms.

Work. Coal seam about 3 ft 6 in thick. Works sitting on a small stool or "cracket" Under cuts the coal for a distance of 2 ft 6 inches, drills holes near roof for the reception of an explosive.

Lamp. "Best Patent" (similar to Clanney.)

Nystagmus. Rotatory type, axial rotation, Brought on when gaze is I0° above horizontal.

Refraction. - 2.25 D.spher. R.V. = 6/6

L. E. - 2. D. sph. + I. D. cyl. axis hor.

L.V. = 8/I0.

Note :- This patient has 6° of Exophoria.

Case No 3

T. C. aet. 37 years

Miner 24 years.

Hewer I9 years.

Complaint. Lamps in the pit "jumping about," also street lamps at night. Giddiness when stooping to fill the tubs with coal. Dull aching pain at back of eyes. Confusion of sight in the dusk.

Duration. First symptoms 2 years ago.

Work. Coal seam is about 4 ft 6in. thick. Patient works sitting on a cracket, he undercuts the face for a distance of 3 feet, drills holes near the roof for his "deputy" to charge with explosives. Symptoms worse when filling tubs.

Lamps. Clanney type.

Refraction. R. E. + .5 D. sph. ⊃ + I.25 D. cyl. axis vertical R.V. = 6/6

L.E. + .5 D. sph. ⊃ - I.75 D. cyl. axis horizontal L.V. = 6/6

Note :- This patient walked with straight back and head well thrown back, he told me that he was "alright as long as he looked straight in front or downwards."

Nystagmus. Lateral. brought out at I0° above hor.

J.S. aet. 26

Miner I2 years.

Hewer 6 years

Complaint. Lamps in the pit "going round". When he looked in the mirror to do his hair he "couldn't make a parting" because his reflection seemed to be going round and round. (Mirror was hung above level of his eyes.) Pain at back of eyes. Giddiness at times. Duration I2 months.

Work. Seam about 4 ft 3 in thick. Worked in a stooping position. Band of shale near top of seam was "corved" out, ie. cut out with pick to a depth of 2 ft. and coal blasted ~~up~~ from below.

Lighting. Clanney type of safety lamp.

Nystagmus. Rotatory, axial type, brought out at 5° above horizontal.

Refraction. R.E. - .5 D. sph.⊂ -I. D. cyl. axis hor.
R. V. = 8/I0
L. E. - .5 D. sph.⊂ - .75 D. cyl. axis hor. L.V. = 6/6

Notes:- "A lot of gas at times," in this mans working place.
He carries his head thrown back, symptoms disappear on looking down, worse on stooping down to fill tubs.

Case No 5.

R. S. aet 29

Miner 9 years.

Hewer 6 years.

Complaint — Heavy feeling in eyes. Lights in pit " moving about." Pain in supra-orbital region. Difficulty in finding his way about at night. Feels giddy when lights appear to move.

Duration — 4 months.

Work. — Coal seam is 6 feet thick. Patient "gets out" the coal by the process of "holing" i.e. he lies on his side and works his way under the coal to a distance of 3 or 4 feet. The coal is then blasted down and "filled" into tubs. Patient notices his symptoms are worst when he is filling tubs in a stooping position.

Lighting. — Safety lamps of the Clanney type.

Nystagmus.. — Rotatory, centre of cornea describes an ellipse, brought out at 10° above hor.

Refraction. — R.E. + .5 D. cyl. axis 100; R. V. = 6/6
L.E. + 3. D. sph. ⊃ +2.25 D. cyl. axis 105, R.V. = 2/10 (Old Iritis, posterior synechiae)

Notes :- — This man appears to have a slight Ptosis as he stands with head thrown back.

Case No 6.

J.B. aet. 42

Miner 2I years

Hewer I4 years.

Complaint Flickering of lamps in the pit, and of the street lamps at night. Pain in the back of the neck. Giddiness at work.

Duration. I year.

Work Coal seam about 4 feet thick. Patient gets the coal by a process known as "bottom corving." He under-cuts the face for about 2 feet 6 in. and wedges the coal down from the roof. Works in a stooping position, head on one side, eyes turned obliquely upwards.

Lighting. Clanney type of safety lamp.

Nystagmus of a rotatory type, axial rotation of cornea, brought out by directing the gaze to a point 5° above the horizontal.

Refraction R.E. + .5 D. cyl. axis vert. R.V. = 6/6
L.E. + I . D. cyl. axis 95° L.V. = 6/6

Notes :- This man shews to a marked extent the characteristic carriage of a nystagmic patient. His back is straight, his head is thrown back , his eyelids droop and nictitation is frequent.

J. L. aet. 35

Miner I6 years

Hewer I2 years.

Complaint Lights going round in circles when at the coal face. Had to close his eyes repeatedly to stop the movements. Often worked with head thrown back so as to prevent his eyes jumping.

Duration has noticed slight movements for 5 years but was not much inconvenienced until after a blow"on the sight " three months ago.

Work Seam 6 ft thick. Works in an almost upright position. Hews coal from whole surface. No bottom corving or holing.

Lighting Safety Lamps, Clanney type.

Nystagmus. Lateral Nystagmus brought out at 20 above the horizontal.

Refraction R.E. + .75 D. sph ⊃ - 3. D Cyl. axis I0°

R.V. 8/I0

L.E. + .5 D. sph. ⊃ -2.25 D. cyl. axis I5° L.V. = 6/I0 (small corneal nebula following blow 3 months ago)

Case No 8.

T, M. aet 47

Miner 25 years.

Hewer I6 years.

Complaint — Lamps in pit seemed to be " spinning " round. Had to keep blinking to keep his eyes steady. Pain at back of eyeballs.

Duration — I8 months.

Work — Seam 3 ft thick. Works sitting on cracket, head on one shoulder. Under-cuts coal-face to a distance of 3 ft. Coal is then blasted down.

Lighting — Safety- lamps, Clanney type.

Nystagmus — Rotatory with a tendency to lateral movements.

Refraction — R. E. -.5 D. sph. ⊃ +2.75 D.cyl. axis vertical R.V. = 6/6

L.E. -.5 D. sph. ⊃ +2.5 D. cyl. axis vertical L.V. = 6/6

Note :- This patient has 2° of Esophoria.

Case No 9.

J.C.B. aet. 65

Miner 54 years

Wagon-way man 48 years.

Complaint — Pain and dimness of vision of left eye following a blow with piece of stone five days ago.

Work — Patient's work consists in looking after the little railway in the main roads. He also has to keep the ropes and tubs, i.e. miniature railway ~~carriages~~ trucks, which carrynthe coal, in order. He has never been a hewer.

Lighting — Safety lamps, Clanney type.

Nystagmus — Rotatory with a tendency to become oblique, brought out when the gaze is directed to a point 25° above the horizontal.

Refraction. — R.E. -I.D. sph. ⊃ - 2.D.cyl. axis vert. R.V. = 8/10

L.E. Refraction could not be estimated owing to a corneal leucoma left by the ulcer, for which patient sought treatment.

Note :- This man had never experienced any discomfort from his nystagmus.

Case No I0.

J.J. aet 38

Miner 25 years

Hewer I3 years

Complaint — Lights in pit revolving. Attacks of dizziness when at work. Occasionally an attack of vomiting. Difficulty in find- his way in the dark.

Duration — I year

Work — Coal seam 4ft thick. Works sitting on crackett, body leaning to one side, head turned sideways. States that eyes always seem to be straining upwards. Bottom corving 2ft 6 in. under coal

Lighting — Miner's Candle, naked flame.

Nystagmus — Rotatory, axial type, brought out when gazing at a point I0° above the horizontal.

Refraction — R.E. +I D. cyl. axis I75° R.V. =6/6

L. E. + .5 D. cyl axis I70° L.V. = 6/6

J.W.J. aet 45

Miner 30 years.

Hewer 2I years.

Complaint Eyes start jumping as soon as he looks at any bright object and then he has a nasty dizzy feeling. Pains at back of eyes.

Duration I7 months

Work Coal seam 3ft 6 in. thick. In parts of the seam there is a middle band of shale and then he does middle holing, in other parts he works the whole face with his pick as he goes. Eyes better when doing middle holing. Pit very warm, coal is unusually dusty and perspiration carries dust into eyes.

Nyatagmus Rotatory, cornea describing a circle, brought out at horizontal and only stopped by looking down to the ground.

Refraction R.E. - .5 sph ⊃ - ID. cyl. axis hor.
R. V. = 6/6
L.E. - .75 D. sph. ⊃ - I D. cyl. axis horizontal L.V. = 6/6

Lighting. Clanney type of safety lamp.

J.L. aet 34

Miner I9 years.

Hewer 8years.

Complaint Lights in pit going round in circles.
Saw a circle of lights instead of one.
Pain across fore-head and in eyeballs.
Feels giddy when stooping or looking up.

Duration Three weeks.

Work. Coal seam 4 ft thick. Works sitting on a cracket. Bottom corving to a distance of Ift 6 in., coal then wedged down.

Lighting. Clanney type of safety lamp.

Nystagmus. Rotatory, axial rotation, with a tendency to become vertical at times.
Nystagmus brought out when gaze is at the horizontal and is only stopped by looking down to the ground.

Refraction. R.E. +I D. sph.⊃ -2.25 cyl. axis I50°
R.V. = 8/I0
L.E. + I D. sph.⊃- 2.5 D. cyl. axis I70
L.V. 8/I0

Note. This man attributes the onset of the nystagmus to a blow on the head.

W. B. aet 40.

Miner 28 years

Hewer. I6 years.

Complaint. Lights in pit seem to"shake about." When filling tubs they seem to be all on the move. Dizzy at times. Smyptoms are worse when patient stoops and they pass off when he stands upright.

Duration 6 months.

Work. "Bottom corving" in a seam 3ft. in thickness. Sits on cracket, body very much inclined to one side, head on shoulder, eyes turned obliquely to his work.

Lighting. Clanney type of safety-lamp.

Nystagmus. Lateral type, brought out when gaze is directed to a point 42° above the horizontal.

Refraction R.E. - 6 D. sph. = - I D. cyl. axis I50°
R.V. = 6/I0.
L. E. - 6. D. sph. L.V. = 8/I0.

J.T. aet 30

Miner I8 years.

Hewer I0 years.

Complaint Lamps in the pit "keep jumping up and down." Eyes seem to be continually on the move. Unable to find his way about at dusk. Giddiness at times.

Duration. 6 months.

Work Coal seam 3 ft 6 in. Works down the whole coal face with his pick. Sits on cracket most of the time. No under- cutting.

Lighting Benzine safety lamps are used in this man's seam.

Nystagmus. Rotatory, cornea describes a circle, brought out by directing the gaze to a point I5° above the horizontal.

Refraction. R.E. - 2 D. cyl. axis hor. R.V. =6/6
L. E. - 2.5 D. cyl. axis I5°. L.V. = 6/6

E. B. aet 23.

Miner I0 years.

Hewer 3 years.

Complaint Lamps in pit going round and round at end of "shift". Had to stop work for a few minutes and look down to rest his eyes. On coming out of the pit the street lamps seemed to be rotating. Smyptoms disappear after a nights rest.

Work Coal seam 3ft thick. Never room to stand upright, in any part of the pit. Works sitting down, head nearly touching roof, even when turned to one shoulder. Undercuts coal to distance of 3 ft., coal always blasted.

Lighting. Clanney type of safety-lamp.

Nystagmus. Lateral, brought out at 28° above the horizontal.

Refraction + I. D. cyl. axis I20° R.V. = 6/6

+ .75 D. cyl. axis I20° L.V. = 6/6

T.R. aet I8

Miner 4 years

Has never done hewing.

Complaint When stooping and gazing forwards at his work the lamps seem to be double and they appear to dance up and down.

Work. This boy is a "Putter". His work consists in piloting the small trucks or "tubs" along the narrow ways from the coal face to the main roads of the mine. The seam is 4ft 6in thick, the boy is 5ft I0 in. in height.

Lamps Clanney safety-lamps.

Nystagmus. Vertical, brought out at 30° above the horizontal.

Refraction. R. E. + I.D. cyl. axis vert. R.V. = 6/6
L. E. + .5 D. cyl. axis vert. L.V. =6/6

Note. This case illustrates very well how lack of vertical working space causes ocular strain. This boy had to push "tubs" along a narrow track. To avoid the roof he had to bend his back and flex his head forwards. Therefore, to see where he was going, he had to elevate his eyes.

J.C. aet 30.

Miner II years.

Hewer 8 years.

Complaint. Lights in pit going round in circles. Sees several lights where there is only one. Has to hold head back to keep eyes steady and this makes his neck ache. Giddy at times when eyes are worst.

Duration I8 months.

Work. Hews down the whole face with very little undercutting. Sometimes uses the automatic coal cutter worked by compressed air; "this gives a great deal of dust which is very trying to the eyes."

Lighting. Clanney type of safety lamp.

Nystagmus. Sometimes rotatory sometimes oblique. Brought out at horizontal and stopped by looking to the ground.

Refraction. R.E. - .75 D.sph. ⊃ - I.D. cyl. axis hor. R.V. =8/I0

L.E. - .75 D. sph. ⊃ - I.D. cyl. axis hor. L.V. = 8/I0

J.E. aet 48.

Miner 38 years

Hewer 30 years

Complaint "Cast in left eye." Pain at back of eyes.

Duration Has squinted since childhood.
Has had pain for 3 months.

Work. Coal seam 3ft 6in. thick, band of shale in the middle, patient hews out the shale and drills holes for blasting down the coal.

Lighting. Clanney type of safety lamp.

Nystagmus. Rotatory in which the cornea describes an ellipse, greatest excursion upwards. Brought out 30° above the horizontal.

Refraction R.E. + 2.D. spher. $\simeq$ + 2.5 D. $\overset{\text{cyl.}}{\wedge}$ axis vert.
R.V. = 6/6
L.E. + 2.5 D. sph. $\simeq$ + 2.75 D. cyl. axis.
I00° L.V. = 1/10

Note This patient had never suffered any inconvenience from his nystagmus.
His left eye was amblyopic. He had a left internal strabismus of 22°

M.M. aet 26

Miner I2 years

Hewer 5 years, "shift work " 9 months.

Complaint — Eyes dancing when in the pit. Had to give up hewing and take up shift work on account of his eyes. Pain in occipital region. Unable to see in the dusk. Eyes have improved on shift work but give him trouble when stooping to fill tubs.

Work. — Coal seam 6 ft thick. When hewing patient used to under-cut the coal to a distance of 3 ft. "Shift work" consists in keeping the roadways clear of stone and rubbish generally, this means a good deal of stooping to fill tubs.

Lamps. — Clanney type of safety lamp.

Nystagmus — Lateral, brought out at 30° above the horizontal.

Refraction. — R.E. - 2.5 D. cyl. axis hor. R.V. = 6/6
L.E. - 2.5 D. cyl. axis hor. L.V. = 6/6

G.R. aet 30.

Miner I6 years.

Deputy I0 years.

Complaint — Lights in pit dancing up and down. Feels giddy when he looks at a light. The reflection of lamps on a wet pavement makes him "feel sick."

Duration — I5 months.

Work. — A deputy has to superintend the work of 7 or 8 hewers. He is responsible for their safety. He may have to timber a roof, test for gas, inspect the roof, etc. This man had all of these duties to perform in a seam 3ft 6 in thick. The ocular strain of inspecting a roof in a low seam is very considerable.

Lighting. — Safety-lamps, Clanney type, except when testing for gas when he used a lamp with gauze around flame - very poor light.

Nystagmus. — Rotatory, axial type, brought out at 20° above horizontal.

Refraction — + .5 D. sph. ⊂ - 2.D cyl. axis vert. R.V. =8/I0

+.5D.sph. -2.75D.cyl.axis I70° L.V.=8/I0